CALIFORNIA DIVISION OF MINES AND GEOLOGY
FAULT EVALUATION REPORT FER-190

MIRAGE VALLEY, BLAKE RANCH, AND RELATED FAULTS, SAN BERNARDINO AND LOS ANGELES COUNTIES

by

William A. Bryant
Associate Geologist

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INTRODUCTION

Potentially active faults in western San Bernardino and eastern Los Angeles Counties that are evaluated in this Fault Evaluation Report (FER) include strands of the Mirage Valley, Blake Ranch, Leuhman, Spring, and Kramer Hills faults (figure 1). The western Mojave Desert study area is located in parts of the Adobe Mountain, Jackrabbit Hill, Kramer Junction, Leuhman Ridge, Red Buttes, Rogers Lake South, and Shadow Mountains 7 1/2-minute quadrangles (figure 1). These faults are evaluated as part of a statewide effort to evaluate faults for recency of activity. Those faults determined to be sufficiently active and well-defined are zoned by the State Geologist as directed by the Alquist-Priolo Special Studies Zones Act of 1972 (Hart, 1985).

SUMMARY OF AVAILABLE DATA

The western Mojave Desert study area, located in the Mojave Desert geomorphic province, is characterized by generally northwest-trending, right-lateral strike-slip and oblique-slip faults (Dibblee, 1967; Garfunkel, 1974; Dokka, 1983; Dibblee, 1985). Although the northwest orientation of faults is similar to the active right-slip faults in the central Mojave Desert, the western Mojave Desert is considered to be tectonically inactive by Bull (1978). Topography in the study area generally consists of gently sloping pediment surfaces and eroded hills of moderate relief. Development in the study area is generally low and most of the Leuhman, Spring, and Kramer Hills faults lie on bombing and gunnery ranges within the Edwards Air Force Base (EAFB) military reservation. Rock types in the study area consist predominantly of weathered Mesozoic granitic rocks, pre-Mesozoic metamorphic rocks, minor Tertiary sedimentary and volcanic rocks, Pleistocene and Holocene alluvium, eolian, and playa deposits (Dibblee, 1960a, 1960b; Ponti and Burke, 1980).

MIRAGE VALLEY FAULT

The Mirage Valley fault is a 32-km-long, northwest-trending, high-angle fault mapped by Dibblee (1960a, 1960b), Troxel and Gunderson (1970), and Ponti and Burke (1980) (figures 2a, 3). The Mirage Valley fault presumably is a right-lateral strike-slip fault (Ponti and Burke, 1980; Ziony and Wentworth, 1985), although Dibblee (1960a, 1985) indicates that a component of vertical displacement (northeast side up) occurs along the fault. The Mirage Valley fault is located almost exclusively within a pediment along the west side of the Shadow Mountains. The fault offsets Mesozoic granitic rocks, juxtaposes bedrock against Pleistocene alluvium, and, locally, offsets Pleistocene alluvium (Dibblee, 1960b; Troxel and Gunderson, 1970; Ponti and Burke, 1980) (figure 2a). Dibblee (1960b) mapped Holocene alluvium offset along the Mirage Valley fault at locality 1 (figure 2a), and granitic bedrock juxtaposed against Holocene alluvium (localities 2 and 3, figure 2a). However, Dibblee (1985) stated that Holocene alluvium is not offset along the Mirage Valley fault and that latest movement along the fault was probably greater than 200,000 ybp.

Ponti and Burke (1980) mapped segments of the Mirage Valley fault as delineated by "sharp scarps" in pediment surfaces and locally as scarps in late Pleistocene alluvium (localities 1 and 2, figure 2a). A 300-meter-long, west-trending fault segment was mapped by Ponti and Burke as offsetting Holocene alluvium (locality 4, figure 2a). The Pleistocene alluvium mapped by Ponti and Burke at locality 1 (figure 2a) is undifferentiated terrace and alluvial fan material characterized by moderately to well-developed soils with blocky textural B horizons. These deposits may correlate with the Riverbank Formation of the San Joaquin Valley and range in age from about 450,000 ybp to about 140,000 ybp (Ponti and Burke, 1980).

Merriam and others (1985) evaluated segments of the Mirage Valley fault and concluded that the fault was Holocene active, based on the presence of soil-filled fissures along the fault and offset alluvium exposed in trench excavations (figures 2a, 4). A 4 1/2-meter-wide fault zone in Mesozoic quartz monzonite exposed in trench T-2 was reported to have horizontal striations along N50°W 60°N fault planes. Fissures within the fault zone are filled with both a reddish soil presumed to be late Pleistocene in age and a yellow-brown soil (Holocene?) similar to the soil overlying the bedrock. Soil overlying the fault zone is not offset. Vertically offset older alluvium was reported in trench T-4 (figures 2a, 4). Quartz monzonite is faulted over reddish-brown alluvium about 1 meter in an apparent northeast-side-up reverse sense. A thin, overlying soil is not offset and no scarp is shown on the trench log, indicating that the ground surface has been eroded after the last surface faulting event. Merriam and others (1985) stated that, although the Mirage Valley fault is prominent on air photos, it is not delineated by geomorphic evidence of recent faulting.

Ziony and Wentworth (1985) reported the Mirage Valley fault to have evidence of late Pleistocene displacement, but the fault is covered by unfaulted Holocene alluvium.

BLAKE RANCH FAULT

The Blake Ranch fault is an approximately 11-km-long, northwest-trending right-lateral strike-slip fault (Dibblee, 1960a, 1985) (figure 2b). A minor component of vertical displacement (up-to-northeast) was reported by Dibblee (1960a, 1985). A pegmatite-aplite dike body is offset right-laterally about 0.8 km along the Blake Ranch fault (locality 5, figure 2b).

The Blake Ranch fault principally offsets weathered Mesozoic granitic rocks. A Quaternary fanglomerate unit is juxtaposed against granitic bedrock near the northwest end of the fault (locality 6, figure 2b), but this fanglomerate unit is not offset at the southeast end of the Blake Ranch fault (locality 7, figure 2b) (Dibblee, 1960a). This fanglomerate unit is unconformably overlain by late Pleistocene alluvium elsewhere in the study area and Dibblee (1960a) stated that the fanglomerate possibly could be as old as late Pliocene.

Both Dibblee (1960a) and Merriam and others (1985) reported that the Blake Ranch fault is prominent on air photos, but is poorly defined in the field, delineated mainly by a zone of pulverized rock or loamy soil. Dibblee (1985) concluded that the Blake Ranch fault does not offset Holocene deposits and that the latest movement along the fault was greater than 100,000 ybp.

LEUHMAN FAULT

The Leuhman fault is a 20-km-long, northwest-trending inferred fault mapped by Dibblee (1960a) (figure 2b). The sense of displacement is not known, but Dibblee inferred that a vertical component of displacement (southwest side up) has occurred along the Leuhman fault during late Tertiary time. The Leuhman fault mapped by Dibblee is concealed by Holocene alluvium (figure 2b).

SPRING FAULT

The Spring fault is a 22-km-long, northwest-trending, high angle fault mapped by Dibblee (1960a) along the southern Kramer Hills (figure 2b). Displacement along the Spring fault is not well-constrained. The northwestern segment of the fault juxtaposes granitic bedrock on the northeast against Holocene alluvium, indicating an up-to-the-northeast component of vertical displacement. Dibblee (1985) stated that the Spring fault offsets Quaternary fanglomerate about 300 meters in a right-lateral sense. Along the southeast segment of the Spring fault, Tertiary sedimentary rocks are offset in an up-to-the-southwest vertical sense. Dibblee (1960a) mapped Holocene alluvium as offset along the southeastern segment of the Spring fault (locality 8, figure 2b). However, Dibblee (1985) stated that Holocene alluvium was not offset along the Spring fault and that the most recent movement along the fault was probably greater than 200,000 ybp and possibly more than 700,000 ybp.

KRAMER HILLS FAULT

The Kramer Hills fault in the study area is an approximately 8-km-long, northwest-trending fault mapped by Dibblee (1960a) along the south side of the Kramer Hills (figure 2b). The sense of displacement along the Kramer Hills fault is not well-known, but Dibblee (1960a) indicated that the predominant sense of displacement is right-lateral oblique-slip, based on an apparent right-lateral offset of Quaternary fanglomerate deposits. An up-on-the-northeast vertical component of displacement may only be apparent, according to Dibblee (1960a). Dibblee (1960a) mapped a segment of the Kramer Hills fault as juxtaposing Holocene alluvium against Quaternary fanglomerate (figure 2b). A short fault segment just southwest of the Kramer Hills fault is mapped by Dibblee (1960a) as offsetting Holocene alluvium (locality 9, figure 2b). However, Dibblee's (1960a) cross sections E-E' and F-F' show this short fault segment to be overlain by unfaulted Holocene alluvium. Dibblee (1985) stated that the Kramer Hills fault is, in part, younger than the Pleistocene fanglomerate, but older than Holocene alluvium and thus has not been active for more than 10,000 years.

WEST-TRENDING FAULTS NORTH OF MT. MESA

Several west-trending faults in granitic bedrock north of Mt. Mesa were mapped by Dibblee (1960a) and Ponti and Burke (1980) (figure 2a). Dibblee (1960a) stated that these features were prominent on air photos, but he was uncertain as to whether these features were faults, joints, or large fractures. Ponti and Burke (1980) mapped many, generally north-facing scarps, both sharp and subdued, in granitic bedrock (figure 2a--note: not all faults plotted on figure 2a). The magnitude and sense of offset are not known for any of these features, although it is likely that the predominant sense of offset is up-on-the-north reverse.

Merriam and others (1985) reported that west-trending lineaments north of Mt. Mesa mapped by Ponti and Burke (1980) do not have any topographic expression. These features apparently show up on air photos due to caliche weathering out along the fractures and faults.

INTERPRETATION OF AERIAL PHOTOGRAPHS AND FIELD OBSERVATIONS

Aerial photographic interpretation by this writer of faults in the western Mojave Desert study area was accomplished using U.S. Department of Agriculture (AXL and AXJ 1952, scale 1:20,000) and U.S. Bureau of Land Management (CAHD-77, 1978, scale 1:30,000) air photos.

Approximately four days were spent in the study area in February 1987 by this writer. Selected fault segments were field checked and subtle features not observable on the aerial photographs were mapped in the field. Results of aerial photographic interpretation and field observations by this writer are summarized on figures 2a, 2b, and 3.

MIRAGE VALLEY FAULT

The Mirage Valley fault zone throughout most of the study area is delineated by moderately well-defined tonal lineaments in weathered granitic bedrock (figure 3). The pediment surfaces in the study area are characterized by many generally well-defined tonal lineaments that delineate faults, fractures, and joints. However, geomorphic evidence of recent, systematic right-lateral strike-slip displacement along the Mirage Valley fault was not observed by this writer, based on air photo interpretation and field observations (figures 2a, 3).

The Mirage Valley fault zone is delineated by geomorphic features more characteristic of differential erosion along a fault, such as broad troughs and truncated ridges in weathered granitic bedrock at localities 10 and 11 (figure 3). Moderately well-defined tonal lineaments in weathered bedrock observed on air photos are poorly defined in the field and are usually delineated by broad vegetation contrasts and zones of caliche fragments at the surface.

Evidence of late Quaternary faulting was observed at localities 12 and 13 (figure 3). A very subtle, approximately 1-meter-high, southwest-facing scarp in late Pleistocene alluvium is poorly defined and locally is mantled with an approximately 1/2-meter-thick veneer of unfaulted Holocene alluvium (locality 12, figure 3). At locality 13, a rounded, dissected scarp in late Pleistocene alluvium is also partly concealed by unfaulted Holocene alluvium (figure 3). A pre-Holocene age for the pediment surfaces is indicated at locality 14, where Bt soil horizons with stage III carbonate morphology are developed on weathered granitic bedrock (figure 3). This prominent soil is not offset along the Mirage Valley fault near locality 14 (figure 3).

Trench sites excavated by Merriam and others (1985) were field checked in order to observe the geomorphic expression of the Mirage Valley fault (figure 3). No geomorphic evidence was observed that would indicate recent faulting. A significant component of vertical displacement was reported in trenches T-4 and T-5 where granitic bedrock is faulted over older alluvium (figures 3, 4). No evidence of a southwest-facing scarp was observed by this writer, either on air photos or during the field check.

Fault traces mapped by Dibblee (1960a, 1960b), Troxel and Gunderson (1970), and Ponti and Burke (1980) locally were verified by this writer (figures 2a, 3). Evidence of Holocene displacement mapped by Dibblee (1960a) at locality 1 was not verified by this writer (figure 2a). The sharp scarps in pediment surfaces and Pleistocene alluvium mapped by Ponti and Burke (1980) were not verified by this writer (figure 2a). Scarps, where they exist along the Mirage Valley fault, are poorly defined, subdued, and generally are covered by a veneer of unfaulted Holocene alluvium (figure 3).

BLAKE RANCH FAULT

The Blake Ranch fault is a moderately defined fault in granitic bedrock that is delineated by geomorphic features more characteristic of differential erosion that recent faulting, such as subtle troughs and eroded scarps in bedrock (localities 5, 15-17, figure 2b). Systematic right-laterally offset drainages were not observed, and ridges are not offset where they cross the Blake Ranch fault (figure 2b). The fault is poorly defined where Dibblee (1960a) mapped offset Pleistocene fanglomerate (locality 6), and there is no geomorphic evidence of faulting in these Pleistocene deposits at the southeast end of the fault (locality 7, figure 2b).

LEUHMAN FAULT

The Leuhman fault mapped by Dibblee (1960a) was not verified by this writer, based on air photo interpretation (figure 2b). A short fault trace near the southeastern end of the Leuhman fault is delineated by tonal lineaments and dissected scarps in what Dibblee (1960a) mapped as Holocene alluvium (locality 18, figure 2b). However, the scarps are in what appears to be weathered bedrock and may, in part, be erosional, based on air photo interpretation by this writer.

SPRING FAULT

The Spring fault mapped by Dibblee (1960a) was partly verified by this writer, based on air photo interpretation (figure 2b). The northwestern part of the Spring fault is delineated by a dissected, southwest-facing scarp in granitic bedrock (figure 2b). Dibblee mapped Holocene alluvium juxtaposed against bedrock at this location, but there is no geomorphic evidence that the alluvium is offset (locality 19, figure 2b). The Spring fault is not well-defined to the southeast and the offset Holocene alluvium mapped by Dibblee (1960a) in the area near locality 8 was not verified by this writer, based on air photo interpretation (figure 2b).

KRAMER HILLS FAULT

The Kramer Hills fault mapped by Dibblee (1960a) was mostly verified by this writer, although differences in detail exist (figure 2b). The northwest segment of the Kramer Hills fault is poorly defined and is not delineated by geomorphic evidence of recent faulting. The southeast segment of the Kramer

Hills fault is delineated by a moderately defined southwest-facing scarp in Dibblee's Pleistocene fanglomerate and alluvium (locality 2a, figure 2b). Geomorphic evidence of systematic right-lateral strike-slip displacement was not observed along the Kramer Hills fault. The southwest-facing scarp near locality 20 is very subtle and is covered with a veneer of unfaulted Holocene alluvium (figure 2b).

The short northwest-trending fault in Holocene alluvium mapped by Dibblee (1960a) at locality 9 was not verified by this writer (figure 2b).

WEST-TRENDING FAULTS NORTH OF MT. MESA

Several west-trending tonal lineaments in weathered granitic bedrock mapped by Dibblee (1960a) and Ponti and Burke (1980) were partly verified by this writer (figures 2a, 3). However, no geomorphic evidence of recent faulting was observed along any of these lineaments.

SEISMICITY

Seismicity in the western Mojave Desert study area is depicted in figure 5. A and B quality epicenter locations by California Institute of Technology are for the period 1932 to 1985 (CIT, 1985).

None of the faults evaluated in this FER are associated with zones of microseismicity. A few earthquakes of M 4 are scattered within the study area, but none of these events seem to be associated with individual faults.

CONCLUSIONS

MIRAGE VALLEY FAULT

The Mirage Valley fault is a northwest-trending, right-lateral strike-slip fault (figures 2a, 3). The Mirage Valley fault offsets Mesozoic granitic rocks and, locally, late Pleistocene deposits (e.g., localities 12, 13, figure 3). However, geomorphic evidence of recent right-lateral strike-slip displacement was not observed along the Mirage Valley fault. Dibblee (1985) stated that the Mirage Valley fault was not Holocene active and that, although prominent on air photos, topographic evidence of faulting was not observed in the field. This observation was confirmed by this writer: the Mirage Valley fault, exclusive of tonal lineaments in weathered granitic bedrock, is poorly defined. Merriam and others (1985) concluded that the Mirage Valley fault was Holocene active, based on soil-filled fissures observed in trenches T-2 and T-3 and faulted older alluvium in trenches T-4 and T-5 (figures 2a, 3, and 4). Holocene vertical displacement should be delineated by a scarp in the area around trenches T-4 and T-5, but no geomorphic evidence exists except for a broad tonal lineament (figure 3). Soil-filled fissures along the fault are permissive of minor Holocene displacement. However, the overall lack of geomorphic evidence of recent strike-slip displacement indicates that, if Holocene faulting has occurred along the Mirage Valley fault, it must be extremely minor, and the rate of activity is quite low.

BLAKE RANCH FAULT

The Blake Ranch fault is a northwest-trending, right-lateral strike-slip fault located predominantly within weathered granitic bedrock (Dibblee, 1960a) (figure 2b). The Blake Ranch fault mapped by Dibblee, partly verified by this writer, is generally only moderately defined and is not delineated by geomorphic evidence of recent right-lateral strike-slip displacement (figure 2b). Pleistocene fanglomerate deposits are not offset along the southeastern end of the Blake Ranch fault, and there is no geomorphic evidence of recent faulting along the northwestern end of the fault (figure 2b). Dibblee (1985) stated that the Blake Ranch fault is not Holocene active.

LEUHMAN FAULT

The Leuhman fault is a poorly defined, northwest-trending fault mapped by Dibblee (1960a) as concealed by Holocene alluvium (figure 2b). A short, moderately well-defined fault mapped by this writer near the southern Leuhman fault is characterized by geomorphic features indicating late Pleistocene and, possibly Holocene displacement (figure 2b). However, this fault is relatively minor and is located in a bombing range within the EAFB military reservation.

SPRING FAULT

The Spring fault is a moderate to moderately well-defined, northwest-trending fault mapped by Dibblee (1960a) (figure 2b). The Spring fault is delineated by a dissected, southwest-facing scarp in granitic bedrock along its northwest end, but geomorphic evidence of recent right-lateral strike-slip displacement was not observed (figure 2b). The fault is poorly defined along its southeastern half, and the faulted Holocene alluvium mapped by Dibblee (1960a) was not verified by this writer (locality 8, figure 2b). Dibblee (1985) stated that the Spring fault was not Holocene active.

KRAMER HILLS FAULT

The Kramer Hills fault is a northwest-trending, right-lateral strike-slip fault with a component of up-on-the-northeast vertical displacement (Dibblee, 1960a) (figure 2b). The fault is moderately well-defined along its southeastern end, but geomorphic evidence of recent strike-slip displacement was not observed along the fault (figure 2b). The southwest-facing scarp at locality 20 (figure 2b) is very subtle and is covered by a veneer of Holocene alluvium. It is not known if the scarp is in older alluvium or Pleistocene fanglomerate. However, there is no evidence indicating Holocene activity, and Dibblee (1985) stated that the Kramer Hills fault does not offset Holocene deposits.

RECOMMENDATIONS

Recommendations for zoning faults for special studies are based on the criteria of "sufficiently active" and "well-defined" (Hart, 1985).

MIRAGE VALLEY FAULT

Do not zone for special studies. This fault is poorly defined and evidence of Holocene activity is weak.

BLAKE RANCH FAULT

Do not zone for special studies. This fault is neither sufficiently active nor well-defined.

LEUHMAN, SPRING, AND KRAMER HILLS FAULTS

Do not zone for special studies. These faults are neither sufficiently active nor well-defined.

Report reviewed and recommendations approved. Earl W. Hart 5/1/87

William A. Bryant

William A. Bryant
Associate Geologist
R.G. #3717
May 1, 1987

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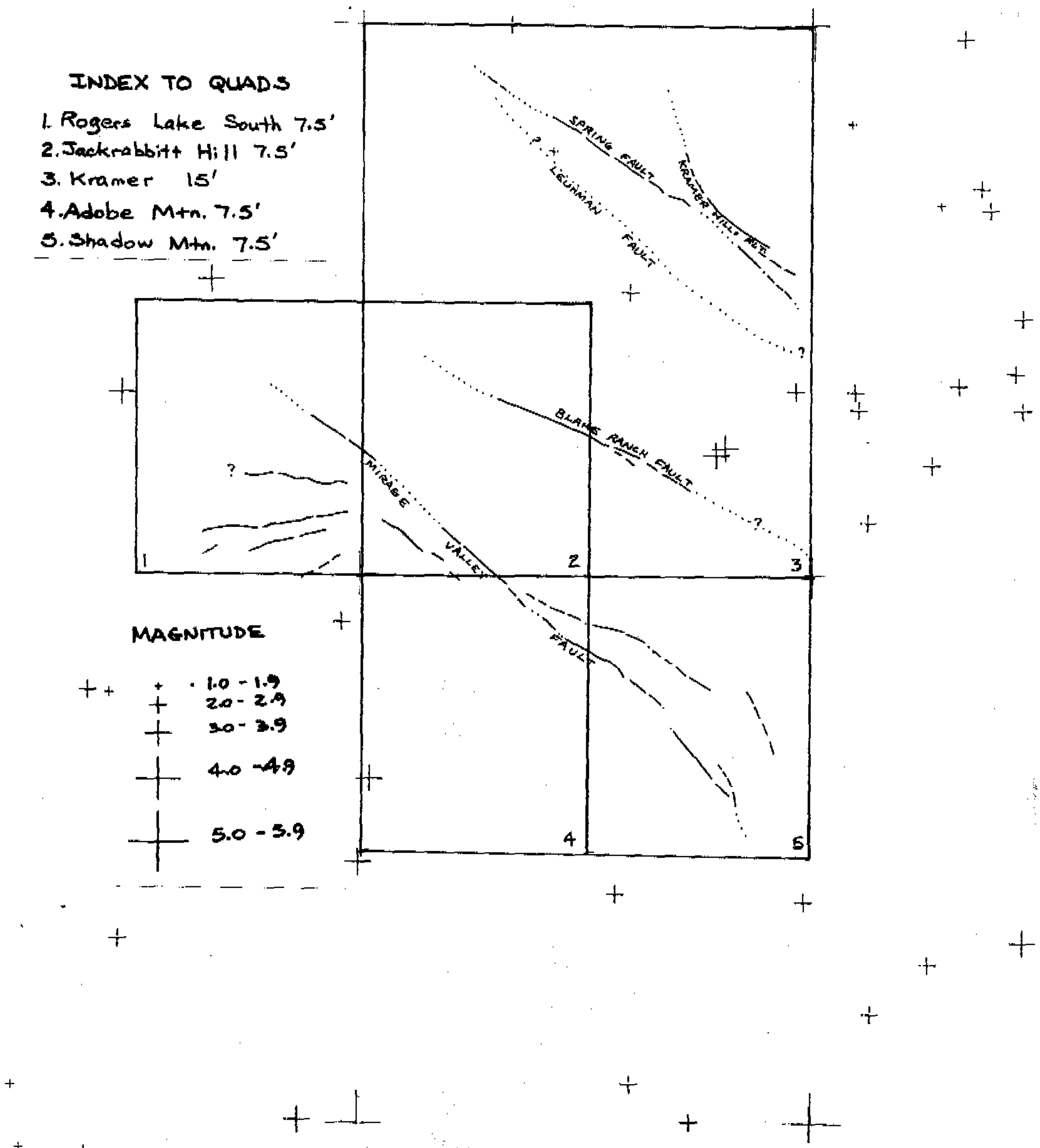

Figure 5 (to FER-190). Seismicity (A and B quality) in the western Mojave Desert study area for the period 1932 to mid-1985, based on locations from California Institute of Technology (1985). Faults are from Bortugno and Spittler (1986), scale 1:250,000.